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ABSTRACT

This study used data from the National Education Longitudinal Study of 1988 (NELS:88) to explore the relationship of teacher quality to student educational attainment by looking at how the quality of a student's eighth-grade mathematics teacher is related to: (1) the highest academic level of mathematics coursework a student completes in high school; (2) high school graduation rates; and (3) postsecondary degree completion rates. It finds that the quality of a student's eighth-grade mathematics teacher is positively related to the three indicators of educational attainment as long as one does not control for the achievement level of the student's eighth-grade mathematics class. When one controls for the achievement level of the student's class, the quality of the teacher is not a significant predictor of attainment. (Contains 5 tables and 15 references.) (Author/SLD)

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Teacher quality and student educational attainment: Findings from the National Education Longitudinal Study (1988-2000)

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Abstract

This paper uses data from the *National Education Longitudinal Study of 1988* (NELS:88) to explore the relationship of teacher quality to student educational attainment by looking at how the quality of a student's 8th-grade mathematics teacher is related to (a) the highest academic level of mathematics coursework a student completes in high school, (b) high school graduation rates, and (c) post-secondary degree completion rates. It finds that the quality of a student's 8th-grade mathematics teacher is positively related to the three indicators of educational attainment as long as one does not control for the achievement level of the student's 8th-grade mathematics class. When one controls for the achievement level of the student's class, the quality of the teacher is not a significant predictor of attainment.

Perspectives and Theoretical Framework

There is a large body of research examining teacher quality and student achievement (Murnane and Phillips, 1981; Ferguson, 1991; Monk and King, 1994; Sanders and Rivers, 1996; Rowan, Chiang, and Miller 1997; Fetler 1999; Mayer,

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Mullens, and Moore, 2000; Darling-Hammond, 2000). This research has used student test scores to evaluate the effectiveness of a range of hypothesized characteristics of teacher quality (e.g., in-field degree, subject matter certification, years of teaching experience, advanced degrees, etc.). Many have specifically focused on mathematics teachers (Monk, 1994; Goldhaber and Brewer, 1997 and 2000). The best studies have controlled for students' prior achievement (i.e., used pre- and post-test scores to examine the 'value added' by teachers rather than assume that the highest student achievement scores correlate with the best teachers) (e.g., Goldhaber and Brewer, 1997; Monk and King, 1994; Darling-Hammond, 2000; Rivkin, Hanushek, and Kain, 2001, etc.). All, however, rely on the assumption that the effects of teacher quality characteristics are 'immediate' (e.g., many studies rely on tests administered half-way through the school year or after only four or five months with the focus teacher) and captured by test scores.

The NELS survey of 8th-graders in 1988, with its second follow-up at the end of high school (1992) and its fourth follow-up eight years after a typical student's high school graduation (2000), allows one to test whether the characteristics of teacher quality that are associated with improved test scores are also associated with long-term effects on a student's education attainment. Specifically, the NELS:88 second follow-up data combined with the "academic pipeline" transcript classification of high school mathematics courses (which classifies courses into eight levels of academic rigor, ranging from "no mathematics" and "non academic" to "advanced academic III"[1]) allows one to

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[1] For a detailed description of the "academic pipeline" for mathematics, see National Center for Education Statistics, *The Condition of Education 2002*, (Washington, DC: U.S. Government Printing Office, 2002), 232-34 (also at http: //nces.ed.gov). The mathematics pipeline was developed by David T. Burkam, Valerie Lee, and Becki A. Smerdon (see Burkam, Lee, and Smerdon, 1997).

test whether having a high (or low) quality teacher in the 8th-grade makes any difference in a student's chances of taking advanced academic mathematics courses in high school, after controlling for student background, ability level, and school characteristics. Furthermore, the NELS:88 fourth follow-up allows one to examine whether having a high (or low) quality mathematics teacher in the 8th-grade (now more and more regarded as the "gatekeeping" grade) makes any difference in a student's chances of finishing high school and completing postsecondary education, after controlling for student background, ability level, and school characteristics. In short, the NELS:88 dataset allows us to explore the question of whether a single highly qualified teacher in a critical subject makes a lasting difference in the academic career of his or her students. Our null hypothesis then is that a single teacher's long-term effect is negligible once one has controlled for student background and school factors.

Data Source and Sample

The *National Education Longitudinal Study of 1988* (NELS:88) is the most current and comprehensive source of information on personal and contextual factors in the educational life of U.S. adolescents over time. It began in 1988 with a cohort of about 24,000 8th-graders. The sample generalized to the 3 million 8th-graders attending the approximately 40,000 public and private schools serving 8th-graders in the U. S. in 1988. Follow-up data were collected in 1990, 1992, 1994, and 2000, and include information obtained from the students, parents, teachers, administrators, and from school

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The rationale for using the mathematics pipeline for this analysis is that mathematics is, by and large, a sequentially progressive subject that can easily be converted into an academic pipeline and easily interpreted. By contrast, English, social studies, and even science course are more difficult to convert into an academic pipeline and far more difficult to interpret (e.g., Is world history at a higher academic level or the same academic level as U.S. history? as economics?; Is AP Biology at a higher academic level or the same academic level as Chemistry II? as AP Physics?).

transcript files. Just prior to the third follow-up in 1994, the decision was made to sub-sample the NELS:88 sample down to 14,000 respondents. Both respondents and non-respondents from the third follow-up sample were selected for the 2000 survey, yielding a sample size of over 12,000 cases.

For each student in the 8th-grade sample, two teachers were surveyed. One of these teachers was either the student's mathematics or science teacher and the other teacher was either the student's English or social studies teacher. For this study we selected cases of students whose mathematics teacher was surveyed by dropping all student cases that lacked 8th-grade mathematics teacher background data. By including only those students whose mathematics teacher was surveyed, we were able to specifically focus on the relationship between mathematics teacher quality and our three outcome variables: mathematics coursetaking in high school, high school completion, and postsecondary attainment. In order to rule out the possibility of bias in the subsample, we calculated frequencies for students who were dropped and for those who were retained. There were no marked differences in the frequency distributions of selected and non-selected students by (1) various student background characteristics (race, socioenomic status, limited English proficiency, parent's education, and mathematics grades from 6th grade until the base year survey), (2) school characteristics (urbanicity composite, geographic region, and the percent of students in the school eligible for free or reduced price lunch), or (3) the highest academic level of mathematics courses taken in high school.

Measures

To examine the effects of a "high quality" teacher on a student's academic career, we (a) created a teacher quality measure, (b) used the National Center of Education Statistics' "mathematics pipeline" variable, and (c) used several outcome and background variables in the NELS:88 dataset.

Teacher Quality

We created a composite variable for teacher quality using the following items from the NELS:88 base year teacher survey: whether or not the teacher had a graduate (BYT310D1) or bachelor's (BYT3_9D1) degree in mathematics, or was certified in mathematics (BYT3_7A); their response to the question "How prepared are you to teach this course?"(BYT2_14); the amount of time they spent "maintaining order and discipline" in the classroom (BYT2_16D); their years of teaching experience at the elementary or secondary level (BYT3_4); and how diligent they were in keeping records on, correcting and returning, and discussing homework (A composite of BYT2_8A, BYT2_8B, and BYT2_8C). Teachers who were not certified and did not have a bachelor's or master's degree in mathematics were coded as low quality teachers if they also reported at least one of the following: (a) being "unprepared" or only "somewhat prepared" to teach 8th-grade mathematics; (b) lacking diligence on at least two homework factors (i.e., teacher reported never or only occasionally (i) keeping records on, (ii) correcting and returning, or (iii) discussing homework); or (c) having taught for 3 or fewer years.[2] About 4.4 percent of the mathematics teachers surveyed fell into the cate-

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[2] The rationale for using inexperience as an indicator of a low quality teacher is that research on teacher experience has indicated that, while there is no positive or linear relationship between years of experience teaching and student achievement, there is evidence that brand new teachers are typically less effective than

gory of low quality teacher. Teachers who had a bachelor's or master's degree in mathematics were coded as *high* quality teachers (about 39.5 percent of teachers) if they also reported that they were "very well prepared" or "well prepared" to teach 8th-grade mathematics. Certain high quality teachers were recoded as *highest* quality teachers (about 3.1 percent of teachers) if they also reported (a) diligence on all three homework factors (i.e., teacher reported most of the time or always (i) keeping records on, (ii) correcting and returning, and (iii) discussing homework) and (b) spending no time maintaining order in the classroom.[3] About 53 percent of the mathematics teachers surveyed did not fall into any of these three categories and were coded as average quality teachers.

Mathematics pipeline

To create a variable for the highest academic level of mathematics completed using student transcript files, we replicated the code used for the analysis and preparation of indicators on high school student coursetaking in *The Condition of Education 2002* (NCES 2002). In the second follow-up (1992), transcripts were collected for a sample (17,281) of the original 8th-grade students, of whom 42 percent (7,264) had an 8th-grade mathematics teacher who was surveyed.

The categories (and percent of students for whom this was the highest academic level of coursetaking they completed) are as follows:

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teachers with at least 5 years of teaching experience (Darling-Hammond, 2000). The category of '3 or fewer years' was the lowest and most appropriate category for inexperience available in the variable BYT3_4.

[3] This choice of this variable as a marker of the highest quality teachers is not a simple one because selecting teachers who do not spend any appreciable amount of time "maintaining order in the classroom" may well select only teachers in the schools that offer the best learning environments, thus biasing any results. However, it was decided to include this self-reported variable because (1) even the best teacher in the world cannot succeed in a classroom that is out of control and (2) even in poor learning environments, effective teachers do maintain order.

No mathematics (2.8 percent): No coursework completed in mathematics by graduates, or only basic or remedial-level mathematics completed. It is thus possible for a graduate to have taken one or more courses in mathematics, but to be placed at this level.

Nonacademic level (9.3 percent): Highest completed courses are in general mathematics or basic skills mathematics, such as: general mathematics I or II; basic mathematics I, II, or III; consumer mathematics; technical or vocational mathematics; and mathematics review.

Low academic level (8.3 percent): Highest completed courses are preliminary courses (e.g., prealgebra) or mathematics courses of reduced rigor or pace (e.g., algebra I taught over the course of 2 academic years). Considered to be more academically challenging than nonacademic courses, courses at this level include prealgebra; algebra I, part I; algebra I, part II; and geometry (informal).

The middle academic level is divided into two sublevels, each of which is considered to be more academically challenging than the nonacademic and low academic levels, though level I is not considered as challenging as level II.

> **Middle academic level I** (21.9 percent): Highest completed courses include algebra I; plane geometry; plane and solid geometry; unified mathematics I and II; and pure mathematics.
>
> **Middle academic level II** (22.0 percent): Highest completed course is algebra II or unified mathematics III.

The advanced academic level is divided into three sublevels, each of which is considered more academically challenging than the nonacademic, low academic, and middle

academic levels, though level I is not considered as challenging as level II, nor level II as challenging as level III.

Advanced academic level I (16.3 percent): Highest completed courses is algebra III; algebra/trigonometry; algebra/analytical geometry; trigonometry; trigonometry/solid geometry; analytical geometry; linear algebra; probability; probability/statistics; statistics; statistics (other); or an independent study.

Advanced academic level II (10.0 percent): Highest completed course is precalculus or an introduction to analysis.

Advanced academic level III (9.4 percent): Highest completed courses is Advanced Placement (AP) calculus; calculus; or calculus/analytical geometry.

Level of educational attainment

High school completion was assessed using the item "Type of HS diploma received as of 2000"(F4HSTYPE) from the 2000 data file, which was recoded as 1 = no diploma or equivalent, 2 = certificate of attendance, 3 = GED, and 4 = high school diploma. Postsecondary educational attainment was assessed with a composite variable created from the 2000 data file's "Degree/certificate earned-1" (F4EDGR1), "Degree/ certificate earned-2" (F4EDGR2) and "Degree/certificate earned-3" (F4EDGR3). This new composite variable was coded for the highest degree/certificate earned among the first three degree/certificates earned (0= no postsecondary degree, 1 = certificate, 2 = associate's degree, 3=bachelor's degree, 4=master's degree, Ph.D. or equivalent, or first-professional degree). In the fourth follow-up (2000), educational attainment data were collected for 5,349 individuals from the original sample of 8th-grade students who had an 8th-grade math teacher surveyed by NELS.

Student variables

The student characteristics used in this analysis include socioeconomic status by quartile (BYSESQ), race/ethnicity (RACE), the student's grades in mathematics from 6th grade until the base year survey (BYS81B), and limited English proficiency status (BYLEP). For our analysis, these variables were dummy coded. Parental education (BYPARED) was also used, and was collapsed into the dummy variable "Parent is a college graduate."

School variables

The school characteristics used in this analysis include school type (BYSC30); urbanicity (G8URBAN); region (G8REGON); school size (BYSCENRL); percent of students eligible for free or reduced-price lunch (G8LUNCH); and the percent minority enrollment in the school (G8MINOR). BYSC30 is coded as 1 for "Public" and 2 for "Private." G8URBAN is coded as 1 for "Urban," 2 for "Suburban," and 3 for "Rural." G8REGON is coded as 1 for "Northeast – New England and Middle Atlantic States," 2 for "North Central – East North Central and West North Central states," 3 for "South – South Atlantic, East South Central, and West South Central states," and 4 for "West – Mountain and Pacific States." We collapsed the categories of BYSCENRL into "1-399 students," "400-599 students," "600-999 students," and "more than 999 students." We collapsed the categories of G8LUNCH into "0-5 percent," "6-20 percent," "31-50 percent," and "51-100 percent." And we collapsed the categories of G8MINOR into "None," "1-5 percent," "6-20 percent," "21-60 percent," and "61-100 percent."

Math class variables

Students' mathematics class size (BYT2_3) was also used in the analysis. This variable was coded from 1 to 44 based on the number of students in the class. For our analysis, this variable was dummy coded and collapsed into "20 or fewer students," "21-25 students," "26-29 students," and "30 or more students." Teacher perception of the achievement level of the students in the class compared to other math class levels (BYT2_2) was used as well. This variable is coded 1 for "higher levels," 2 for "average levels," 3 for "lower levels," and 4 for "widely differing." We recoded this variable into two dummy variables for the "lower levels" and "higher levels."

Procedures

The first step in this study was to conduct preliminary analyses (using crosstabs) to see what discernible patterns, if any, exist to suggest that the quality of a student's 8th-grade mathematics teacher is associated with high school mathematics coursetaking and/or future educational attainment. Finding existing patterns (see Table 1), the second step in this study was to estimate the impact of teacher quality on student coursetaking and educational attainment. This we did by estimating several ordinary least-squares (OLS) regression models with AM software using as the dependent variable the mathematics pipeline variable in the first set of regressions, the type of high school diploma in the second set of regressions, and the highest postsecondary degree in the third set of regressions. We controlled for student background characteristics and ability level as well as various school factors (using the variables described above under Measures) in each regression. AM software weighted all estimates to make them

nationally representative and compensated for the cluster and strata design effects that result from NELS's complex survey design.

The results of the first model can be interpreted as the change in the *highest completed level of high school mathematics coursework* associated with particular teacher quality levels when holding other student and school factors constant. The general equation for this model can be shown as:

$$Y_i = \delta + (\beta_1 T_1 + \beta_2 T_2 \ldots + \beta_i T_i) + (\beta_1 S_1 + \beta_2 S_2 \ldots + \beta_i S_i) + (\beta_1 X_1 + \beta_2 X_2 \ldots + \beta_i X_i) + e_i$$

Where:

Y = Highest academic level of mathematics completed in high school
T_{1-i} = Teacher Quality Characteristics
S_{1-i} = Student Characteristics
X_{1-i} = School Characteristics
δ = constant term
e_i = error term

The results of the second and third model can be interpreted, respectively, as the *change in the type of high school diploma* and change in the *highest postsecondary degree earned* associated with particular teacher quality levels when holding other student and school factors constant. The general equation for each of these models is the same as that for the first model, with Y adjusted accordingly.

Results

Preliminary results

The results of a simple bivariate analysis reveal that students who had the highest quality mathematics teacher in the 8th grade are significantly more likely to have completed advanced academic mathematics level II and III courses in high school than students who did not (see Table 1). They are also less likely to have stopped taking

mathematics at the low academic level in high school. These students are more likely to have graduated from high school (see Table 2) and to have gone on to complete a bachelor's degree by 2000 (see Table 3) than students with an average or low quality mathematics teacher in the 8th grade. Such results suggest the possibility that the quality of a student's 8th-grade mathematics teacher may be associated with educational attainment later in life. However, skepticism suggests that it is more likely that these results indicate that the quality of a student's 8th-grade mathematics teacher are highly correlated with other factors (e.g., better school districts, affluent families, better classes, highly self-motivated students, etc.) that are the true determinant of later educational attainment.

Regression results

The results of our three OLS regressions (to sort out the relative importance of the quality of a student's 8th-grade mathematics teachers when student and school background factors are controlled for) reveal that the quality of a student's 8th-grade mathematics teacher does not turn out to have a significant impact on high school mathematics coursetaking, high school graduation, or postsecondary educational attainment once one controls for the achievement level of the student's 8th-grade mathematics class.

Table 4 shows that when teacher quality is regressed upon the highest academic level of mathematics completed in high school, and only a student's grades and family socio-economic status (SES) are controlled for, teacher quality is a significant determinant of the highest academic level of mathematics completed in high school (see run A). Controlling for parental education, the percentage of students in the school

eligible for free or reduce-price lunch, whether the school is private, urbanicity, region, the percentage of minority students in the school, class size, school size, student race, and whether the student has limited English proficiency (LEP) did not change this result (see run B). However, if one also controls for the teacher's perception of the level of achievement in the class (i.e., whether the teacher reported that students in the 8th-grade mathematics class were above or below the average level), teacher quality no longer remains a significant determinant and the estimated impact of grades, SES, the percentage of students eligible for free or reduce-price lunch, and urbanicity diminishes (see run C). This suggests that an 8th-grade class's achievement level "soaks up" the effect of teacher quality (as well as some of these other factors), perhaps by eliminating the effect of the best students being sorted into the best teachers' classes. For were this occurring, high quality *teaching* would not be a determinant but rather the high quality *teachers* would be an indirect factor by virtue of bringing together students who sustain a high-quality learning environment. This could be because the high quality teachers are more likely to teach the advanced classes (see Table 4a) (though this may be an artifact of the dataset and the construct used in this analysis as this was not found to be the case in an analysis of the National Assessment of Educational Progress (NAEP) 2000 8th-grade mathematics teachers, Provasnik and Young, 2003). Likewise, it could be because bringing together a critical mass of students with higher than average achievement levels raises the performance expectations for all students in the class, or that the teacher's perceptions of the level of their class may be related to their expectations of how well their students will perform, which may in turn have an effect on the performance of their students. Or it may be that there are other factors that we have not controlled for that

would better control for the possibility that the advanced classes are more likely to be in the most affluent schools.

Table 5 shows that when teacher quality is regressed upon the type of high school diploma a student received, only the highest teacher quality is a significant factor (see run A). Once one controls for a student's grades, family socio-economic status (SES), and the level of achievement in the class, teacher quality again is not a significant determinant (see run B). Moreover, being part of a class with a higher than average achievement level is not a predictive factor of high school graduation though being part of a low achievement level class is a negative factor. Once one controls for other factors, however, being in a class with a higher than average achievement level becomes a positive predictor at a 0.1 level of significance (see C).

Table 6 shows that when teacher quality is regressed upon the highest completed level of postsecondary education, a high quality teacher is a significant determinant (at 0.1 level of significance) even controlling for a student's grades and family socio-economic status (SES) (see runs A and B). However, once one controls for the teacher's perception of the class's level of achievement, the effect disappears (see run C). Controlling for the rest of the student background and school factors does not change this result.

Implications

The results of this study suggest that a single high (or low) quality teacher, by virtue of what they bring to the classroom as teachers, does not have any discernible impact on a student's educational career once one controls for the student's background, ability level, and other school factors. However, these results can be seen as suggesting

that having a high quality 8th-grade mathematics teacher increases a student's chances of being in a high quality learning environment, which does have a discernible impact on a student's educational career even after one controls for the student's background, ability level, and other school factors. Thus while we "accept" (or more accurately, cannot reject) the null hypothesis—that a single teacher's long-term effect is negligible once one has controlled for student background and school factors—we cannot say that having the highest quality 8th-grade mathematics teacher makes no difference to later educational attainment. In future research, we will explore further the possibility suggested by this study's findings: that the quality of the teacher may be a marker of other factors, which are more direct determinants of later educational attainment.

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Table 1 - Percentage distribution of students according to the highest academic level of mathematics coursetaking completed in high school, by the quality of 8th-grade mathematics teacher: 1992

Quality of 8th-grade math teacher	Weighted N	No math courses		Nonacademic level		Low academic level		Middle academic level I	
Low quality	40677	0.03 **	(0.01)	0.19	(0.05)	0.08 **	(0.02)	0.23	(0.04)
Average	604448	0.03 ***	(0.01)	0.09	(0.01)	0.10 ***	(0.01)	0.23 **	(0.02)
High quality	445530	0.03 ***	(0.01)	0.09	(0.01)	0.07 ***	(0.01)	0.21	(0.01)
Highest quality	40301	0.00	(0.00)	0.09	(0.04)	0.01	(0.01)	0.14	(0.04)

	Middle academic level II		Advanced academic level I		Advanced academic level II		Advanced academic level III	
Low quality	0.19	(0.04)	0.12	(0.05)	0.12 **	(0.04)	0.04 ***	(0.02)
Average	0.22	(0.02)	0.16	(0.02)	0.10 **	(0.01)	0.07 **	(0.01)
High quality	0.22	(0.01)	0.17	(0.02)	0.09	(0.01)	0.12	(0.01)
Highest quality	0.18	(0.05)	0.16	(0.04)	0.22	(0.05)	0.20	(0.04)

** Significant difference at .05 when compared with Highest quality
*** Significant difference at .001 when compared with Highest quality
NOTE: High school transcript data was not available for all students. Standard errors in parentheses.

Table 2 - Percentage distribution of students according to the type of high school diploma earned, by the quality of 8th-grade mathematics teacher: 1992

Quality of 8th-grade math teacher	Weighted N	No diploma or equivalent		Certificate of attendance		GED		High school diploma	
Low quality	79976	0.19 *	(0.09)	0.01	(0.01)	0.12	(0.07)	0.69 **	(0.09)
Average	718381	0.08 **	(0.02)	0.00	(0.00)	0.06	(0.01)	0.85 *	(0.02)
High quality	537524	0.06 *	(0.01)	0.00	(0.00)	0.11 *	(0.02)	0.83 **	(0.02)
Highest quality	40799	0.03	(0.01)	0.00	(0.00)	0.05	(0.03)	0.92	(0.03)

* Significant difference at .1 when compared with Highest quality
** Significant difference at .05 when compared with Highest quality
NOTE: Standard errors in parentheses.

Table 3 - Percentage distribution of students according to the highest postsecondary degree earned, by the quality of 8th-grade mathematics teacher: 2000

Quality of 8th-grade math teacher	Weighted N	No degree higher than high school diploma		Certificate		Associate's degree		Bachelor's degree		Master's, doctorate, or first professional degree	
Low quality	80180	0.66 *	(0.07)	0.08	(0.03)	0.04	(0.01)	0.15 ***	(0.04)	0.07	(0.04)
Average	719553	0.53	(0.03)	0.12 **	(0.03)	0.08	(0.01)	0.23 **	(0.02)	0.04	(0.01)
High quality	537524	0.50	(0.02)	0.09 **	(0.01)	0.07	(0.01)	0.31	(0.02)	0.03	(0.01)
Highest quality	40799	0.49	(0.06)	0.04	(0.02)	0.05	(0.02)	0.35	(0.06)	0.06	(0.02)

* Significant difference at .1 when compared with Highest quality
** Significant difference at .05 when compared with Highest quality
*** Significant difference at .001 when compared with Highest quality
NOTE: Standard errors in parentheses.

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Table 4 - Effect of teacher quality in 8th-grade mathematics upon highest level of mathematics completed in high school (ordinary least squares regression coefficients with standard errors)

	A		B		C	
Parameter Name	Estimate	SE	Estimate	SE	Estimate	SE
Constant	3.195 ***	0.112	3.538 ***	0.197	3.532 ***	0.205
Mathematics teacher quality						
Low quality teacher	-0.066	0.207	-0.039	0.207	0.101	0.193
High quality teacher	0.15 *	0.078	0.142 *	0.078	0.068	0.072
Highest quality teacher	0.641 **	0.216	0.578 **	0.2	0.09	0.198
Student mathematics grades 6th-8th grade						
Mostly As	1.36 ***	0.094	1.352 ***	0.087	0.971 ***	0.085
Mostly B's	0.64 ***	0.09	0.623 ***	0.083	0.401 ***	0.078
Mostly D's	-0.78 ***	0.173	-0.711 ***	0.151	-0.593 ***	0.13
Mostly below D's	-1.257 ***	0.194	-1.231 ***	0.195	-1.191 ***	0.195
Socio economic status, by quartile						
SES 2nd quartile	0.59 ***	0.098	0.556 ***	0.091	0.44 ***	0.089
SES 3rd quartile	1.287 ***	0.104	1.172 ***	0.104	0.963 ***	0.102
SES 4th quartile - highest	1.816 ***	0.106	1.313 ***	0.137	1.022 ***	0.131
Teacher's perception of achievement level of 8th-grade mathematics class compared to the average						
High compared to average					1.187 ***	0.069
Low compared to average					-0.71 ***	0.103
Parent is a college graduate						
Yes			0.451 ***	0.114	0.377 ***	0.116
Percentage eligible to receive free or reduced price lunch						
6-20 percent			-0.274 **	0.105	-0.273 **	0.092
31-50 percent			-0.365 **	0.117	-0.311 **	0.1
51-100 percent			-0.316 **	0.15	-0.267 **	0.136
Is this a public school						
No			0.527 ***	0.144	0.519 ***	0.141
Urbanicity of school						
Urban			0.202 *	0.109	0.125	0.11
Rural			0.27 **	0.096	0.134	0.087
Region						
North central			-0.003	0.122	0.126	0.113
South			-0.188	0.124	-0.065	0.114
West			-0.237 *	0.136	-0.149	0.128
Percent minority in school						
1-5 percent			0.059	0.114	0.084	0.109
6-20 percent			-0.005	0.116	-0.022	0.108
21-60 percent			0.061	0.128	-0.063	0.124
61-100 percent			0.093	0.18	-0.009	0.174
Mathematics class size						
20 or fewer students			-0.229	0.109	0.012	0.103
21-25 students			-0.083	0.104	0.03	0.097
26-29 students			0.094	0.107	0.21 **	0.101
School enrollment						
1-399 students			-0.159	0.149	-0.153	0.134
400-599 students			-0.128	0.115	-0.086	0.112
600-999 students			-0.068	0.107	-0.057	0.102
Race						
Black			-0.138	0.126	-0.007	0.132
Hispanic			0.089	0.117	0.262 **	0.111
Asian			0.431 **	0.142	0.39 **	0.13
American Indian			0.15	0.373	0.313	0.346
Student is LEP						
Yes			-0.245	0.225	-0.172	0.219
n	4,372		4,150		4,126	
R^2	0.329		0.365		0.481	

***Significant at .001 level
**Significant at .05 level
*Significant at .1 level

NOTE: The reference groups are 'Average quality teacher,' 'Mostly C's,' 'SES 1st quartile - lowest,' 'Achievement level of 8th-grade class is average or widely differing,' 'Parent is not a college graduate,' '0-5 percent eligible to receive free or reduced price lunch,' 'Public school,' 'Suburban,' 'Northeast,' '0 percent minority in school,' 'Mathematics class size of more than 30 students,' 'School enrollment is 1,000 or more,' 'White,' and 'Student is not LEP.'

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Table 4a - Percentage distribution of 8th-grade mathematics teachers according to teacher quality by the achievement level of the 8th-grade class: 1988

Quality of 8th-grade math teacher	Weighted N	Above average class		Average class		Lower than average class		Widely varying levels in class	
Low quality	59584	0.111 ***	(0.04)	0.384	(0.09)	0.307 ***	(0.09)	0.198	(0.08)
Average	706274	0.246 ***	(0.02)	0.392 **	(0.02)	0.195 ***	(0.02)	0.168 ***	(0.02)
High quality	539323	0.329 ***	(0.02)	0.397 **	(0.02)	0.159 ***	(0.02)	0.115 **	(0.02)
Highest quality	42982	0.655	(0.07)	0.257	(0.06)	0.043	(0.02)	0.045	(0.02)

* Significant difference at .1 when compared with Highest quality

** Significant difference at .05 when compared with Highest quality

*** Significant difference at .001 when compared with Highest quality

NOTE: Standard errors in parentheses.

Table 5 - Effect of teacher quality in 8th-grade mathematics upon type of high school diploma received by 2000 (ordinary least squares regression coefficients with standard errors)

	A		B		C	
Parameter Name	Estimate	SE	Estimate	SE	Estimate	SE
Constant	3.69 ***	0.049	3.413 ***	0.109	3.525 ***	0.152
Mathematics teacher quality						
Low quality teacher	-0.385	0.27	-0.002	0.112	0.003	0.114
High quality teacher	0.022	0.067	0.01	0.06	0.031	0.048
Highest quality teacher	0.178 **	0.064	0.017	0.067	0.018	0.075
Student mathematics grades 6th-8th grade						
Mostly As			0.124	0.083	0.171 **	0.056
Mostly B's			0.069	0.079	0.072	0.067
Mostly D's			-0.419 **	0.204	-0.475 **	0.191
Mostly below D's			-0.582 **	0.283	-0.593 **	0.249
Socio-economic status, by quartile						
SES 2nd quartile			0.337 ***	0.097	0.271 ***	0.083
SES 3rd quartile			0.391 ***	0.097	0.328 ***	0.084
SES 4th quartile - highest			0.433 ***	0.089	0.39 ***	0.093
Teacher's perception of achievement level of 8th-grade mathematics class compared to the average						
High compared to average			0.086	0.052	0.084 *	0.051
Low compared to average			-0.313 **	0.112	-0.226 **	0.073
Parent is a college graduate						
Yes					-0.03	0.051
Percentage eligible to receive free or reduced price lunch						
6-20 percent					-0.1	0.063
31-50 percent					0.007	0.074
51-100 percent					-0.117	0.126
Is this a public school						
No					0.114	0.079
Urbanicity of school						
Urban					-0.046	0.069
Rural					0.09 *	0.054
Region						
North central					0.029	0.067
South					-0.024	0.069
West					0.051	0.088
Percent minority in school						
1-5 percent					-0.063	0.059
6-20 percent					-0.121 *	0.066
21-60 percent					-0.095	0.071
61-100 percent					-0.198	0.126
Mathematics class size						
20 or fewer students					-0.153 **	0.067
21-25 students					-0.053	0.055
26-29 students					-0.16 **	0.078
School enrollment						
1-399 students					0.035	0.098
400-599 students					0.155	0.095
600-999 students					0.127	0.093
Race						
Black					0.14	0.101
Hispanic					0.07	0.096
Asian					0.052	0.138
American Indian					-0.283	0.413
Student is LEP						
Yes					-0.469	0.304
n	5,347		5,122		4,901	
R^2	0.014		0.154		0.199	

***Significant at .001 level

**Significant at .05 level

*Significant at .1 level

NOTE: The reference groups are 'Average quality teacher,' 'Mostly C's,' 'SES 1st quartile - lowest,' 'Achievement level of 8th-grade class is average or widely differing,' 'Parent is not a college graduate,' '0-5 percent eligible to receive free or reduced price lunch,' 'Public school,' 'Suburban,' 'Northeast,' '0 percent minority in school,' 'Mathematics class size of more than 30 students,' 'School enrollment is 1,000 or more,' 'White,' and 'Student is not LEP.'

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Table 6 - Effect of teacher quality in 8th-grade mathematics upon highest postsecondary degree received by 2000 (ordinary least squares regression coefficients with standard errors)

	A		B		C		D	
Parameter Name	Estimate	SE	Estimate	SE	Estimate	SE	Estimate	SE
Constant	1.125 ***	0.051	0.249 **	0.079	0.327 ***	0.077	0.894 ***	0.171
Mathematics teacher quality								
Low quality teacher	-0.224	0.209	0.114	0.164	0.183	0.156	0.183	0.176
High quality teacher	0.161 *	0.08	0.099 *	0.059	0.056	0.056	0.054	0.058
Highest quality teacher	0.318 *	0.191	0.032	0.158	-0.178	0.174	-0.187	0.176
Student mathematics grades 6th-8th grade								
Mostly As			0.588 ***	0.073	0.471 ***	0.073	0.491 ***	0.071
Mostly B's			0.298 ***	0.079	0.241 **	0.079	0.23 **	0.081
Mostly D's			-0.477 ***	0.125	-0.449 ***	0.126	-0.439 ***	0.107
Mostly below D's			-0.489 **	0.172	-0.509 **	0.22	-0.446 **	0.218
Socio-economic status, by quartile								
SES 2nd quartile			0.382 ***	0.083	0.333 ***	0.079	0.234 ***	0.073
SES 3rd quartile			0.714 ***	0.084	0.648 ***	0.086	0.49 ***	0.083
SES 4th quartile - highest			1.454 ***	0.087	1.296 ***	0.085	0.85 ***	0.123
Teacher's perception of achievement level of 8th-grade mathematics class compared to the average								
High compared to average					0.432 ***	0.075	0.469 ***	0.074
Low compared to average					-0.293 ***	0.076	-0.263 ***	0.064
Parent is a college graduate								
Yes							0.344 ***	0.099
Percentage eligible to receive free or reduced price lunch								
6-20 percent							-0.231 **	0.094
31-50 percent							-0.196 **	0.093
51-100 percent							-0.337 **	0.121
Is this a public school								
No							0.365 **	0.125
Urbanicity of school								
Urban							-0.155 *	0.081
Rural							0.055	0.076
Region								
North central							-0.042	0.093
South							-0.161 *	0.096
West							-0.388 ***	0.103
Percent minority in school								
1-5 percent							0.001	0.099
6-20 percent							0.026	0.107
21-60 percent							0.054	0.123
61-100 percent							0.176 *	0.132
Mathematics class size								
20 or fewer students							-0.137	0.096
21-25 students							-0.077	0.096
26-29 students							-0.119	0.089
School enrollment								
1-399 students							-0.178	0.123
400-599 students							-0.202 *	0.117
600-999 students							-0.15	0.093
Race								
Black							-0.107	0.105
Hispanic							-0.116	0.102
Asian							-0.087	0.12
American Indian							-0.346 **	0.162
Student is LEP								
Yes							-0.249 **	0.126
n	5,349		5,212		5,123		4,902	
R^2	0.006		0.224		0.252		0.295	

***Significant at .001 level
**Significant at .05 level
*Significant at .1 level

NOTE: The reference groups are 'Average quality teacher,' 'Mostly C's,' 'SES 1st quartile - lowest,' 'Achievement level of 8th-grade class is average or widely differing,' 'Parent is not a college graduate,' '0-5 percent eligible to receive free or reduced price lunch,' 'Public school,' 'Suburban,' 'Northeast,' '0 percent minority in school,' 'Mathematics class size of more than 30 students,' 'School enrollment is 1,000 or more,' 'White,' and 'Student is not LEP.'

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